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Control of Diabetes During Pregnancy Using Continuous Insulin Infusion

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POOR CONTROL of diabetes during pregnancy is fraught with increased risk of complications in both mother and fetus.[1,2] Good control of diabetes reduces the rate of occurrence of complications.[3] Continuous subcutaneous insulin infusion (CSII) by pump is a way to maintain serum glucose at near-normal levels in nonpregnant diabetic patients.[4] Plasma glucose can be maintained at near-normal levels with intravenous insulin infusions during childbirth and this reduces complications in the mother and in the newborn.[5] Home monitoring of blood glucose during pregnancy helps the patient achieve normoglycemia.[6] However, we know of no other detailed reports about the usefulness of concurrent CSII and home monitoring of glucose in controlling diabetes during several months of pregnancy.

ABBREVIATION USED IN TEXT

CSII = continuous subcutaneous insulin infusion

The purpose of this paper is to report the effectiveness and practicality of diabetes control in pregnancy using CSII and home glucose monitoring. We studied two high-risk pregnant diabetic women during the last 15 and 23 weeks of pregnancy, respectively. Glucose control was better in both women while using CSII than with previous treatment regimens. Though some diabetic complications developed in the patients, each was delivered of a small baby near term.

Patients, Materials and Methods

After informed discussion and consent, glucose control was studied with continuous subcutaneous insulin infusion and home monitoring of blood glucose in two diabetic women during the final 15 and 23 weeks of their pregnancies, respectively. Patient information is presented in Table 1. Serum glucose control was poor in each woman before and during early pregnancy. Patient 1 had proliferative retinopathy and was classified as having White class R diabetes.[7] Before beginning CSII therapy, she had fasting and random glucose concentrations of 300 to 400 mg per dl. She also had frequent insulin reactions. Her glucose control remained very difficult even when multiple insulin injections were given each day. Patient 2 had systolic and diastolic hypertension and was classified as having class D_5 diabetes. She had fasting serum glucose levels of 192 to 293 mg per dl and 4 PM glucose levels of 189 to 488 mg per dl despite exercise, adherence to diet and three insulin injections per day before the CSII therapy was begun. Other complications in these two patients are listed in Table 1.

Continuous subcutaneous insulin infusion was by a portable battery-powered pump (Model AS2C, Auto Syringe, Inc., Hooksett, New Hampshire). Insulin was infused at a constant basal rate; preprandial pulses of insulin were infused as needed. Subcutaneous catheters from infusion pumps were changed at two- to four-day intervals.

Finger-prick blood dropped onto glucose-

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oxidase reagent strips (Dextrostix, Ames Co., Elkhart, Indiana) was used to determine serum glucose concentration two to four times a day in a portable colorimetric reflectance meter (Eyetone, Ames Co.). The patients recorded the results of all blood tests. Changes in insulin dosage were based on the blood glucose values recorded by the patients. The status of the patients and results of the self-testings were evaluated at weekly intervals by a physician.

Serum glucose levels (one to four times a month) were determined in the hospital laboratory as an independent measure of diabetic control. We found that 34 blood glucose measurements by patients using reflectance meters correlated well with simultaneous laboratory determinations ($r = 0.94$, $P < .001$).

TABLE 1.—*Profiles of Two Pregnant Women Using Continuous Subcutaneous Insulin Infusion (CSII) to Control Diabetes*

	Patient 1	Patient 2
Age	26	21
Duration of diabetes (years)	19	12
Hospital admissions for DKA	0	13
Previous pregnancies	0	2
Stillbirths	..	1
Toxemia	..	2
Complications of diabetes		
White classification[7]	R	D_5
Neuropathy		
Peripheral	+	−
Autonomic	+	−
Retinopathy	+	−
Nephropathy	−	−
Duration of CSII during pregnancy		
Weeks	23	15

DKA = diabetic ketoacidosis.

TABLE 2.—*Mean, Median and Standard Deviations of Serum Glucose Values While Fasting and at 4 PM by Month of Pregnancy During Continuous Subcutaneous Insulin Infusion*

		Patient 1			Patient 2		
		Mean	Median	SD	Mean	Median	SD
Month	Time	mg/dl			mg/dl		
4	Fasting	102	90	49			
	4 PM	119	100	74			
5	Fasting	115	115	57			
	4 PM	142	130	71			
6	Fasting	97	78	46	131	130	49
	4 PM	111	120	58	138	92	113
7	Fasting	139	135	55	178	169	57
	4 PM	122	105	57	140	132	59
8	Fasting	103	83	56	175	170	39
	4 PM	95	80	59	145	139	59
9	Fasting	103	105	18	137	135	39
	4 PM	120	120	34	117	121	55

Results

Blood glucose control was reasonably good in both patients during pregnancy using CSII therapy. Glucose concentrations determined while fasting and each day at 4 PM are shown in Table 2. Patient 1 determined her fasting glucose concentration 117 times and 4 PM glucose 111 times. Patient 2 determined her fasting glucose 107 times and 4 PM glucose 83 times.

Symptoms and signs of proved gastric autonomic neuropathy in patient 1 resolved after 2½ months of receiving CSII therapy. She was admitted to hospital once during the third trimester of her pregnancy for treatment of pyelonephritis. Her proliferative retinopathy advanced during pregnancy and laser therapy was required. At 37 weeks of gestation cesarean section was carried out because of preeclampsia. Her 2.8-kg infant aspirated amniotic fluid but went home with his mother five days after birth in good condition.

Patient 2 was treated with CSII during the last 15 weeks of pregnancy. Though her diabetes was controlled reasonably well (Table 2), she required two hospital admissions for treatment of toxemia. She was delivered of a 3.3-kg infant at 37 weeks of gestation. The infant had modest respiratory difficulty and jaundice but went home with his mother five days after birth.

No infections occurred at sites of subcutaneous catheter insertion. One pump failure occurred in the case of patient 1, which prevented her from receiving her small basal insulin dose one night. She resumed her schedule of basal and bolus insulin and her fasting and 4 PM glucose values the same day were 220 mg per dl and 70 mg per dl. The following day her fasting blood glucose value was 120 mg per dl. In no case did pump malfunction or incorrect reflectance meter reading cause an error in patient management decisions. Each patient achieved glucose control using CSII and home monitoring of blood glucose much better than during her many years of diabetes before CSII.

Patient 1 had eight blood glucose determinations that were less than 50 mg per dl. Patient 2 had ten blood glucose values of less than 50 mg per dl and recorded the sensation of insulin reaction on eight other occasions when her blood

glucose level was higher than 50 mg per dl or was not measured.

In both patients increased amounts of insulin were required during the last two months of pregnancy. Patient 1 used 80 to 90 units of insulin a day in the last two months of pregnancy, compared with 45 to 55 units before that time. Patient 2 required 60 to 70 units of insulin a day in the last two months, compared with a maximum of 50 units during the seventh month of pregnancy.

Comments

While diabetes is often difficult to manage during pregnancy, good control reduces maternal and fetal complications. Fetal mortality decreases from about 30 percent to 4.5 percent when maternal diabetes is well stabilized.[1-3,8,9] Very good control often requires a regimen of multiple injections of insulin each day.

In two high-risk diabetic women whose control was poor before starting CSII therapy, despite multiple daily insulin injections, we showed that CSII improved glucose regulation for the final 15 and 23 weeks of pregnancy. Because retinopathy or toxemia worsened in our patients, we must assume that CSII may not prevent the progression of certain complications. While more rigid regulation of blood glucose concentration (particularly in patient 2) might possibly have prevented toxemia, this is not necessarily so. Factors other than hyperglycemia are involved in the development of toxemia of pregnancy, some of which have not yet been elucidated.[10-12] It is encouraging that the gastric distention and retention, vomiting and diarrhea subsided in patient 1 after 2½ months of improved glucose control. There has been one report that motor-nerve conduction velocity improved after six weeks of good glucose regulation by CSII.[13]

Control of diabetes by CSII and frequent blood glucose monitoring at home require a lot of cooperation by both patient and physician. The patient must be conscientious and able to devote about half an hour a day to the mechanics of CSII, plus determining finger-prick blood glucose concentrations and keeping a record of results of all glucose determinations. The purchase price of the infusion pumps, reflectance meters and blood-glucose reagent strips was $1,150, $300 and 40 to 45 cents each, respectively (1980 prices).

We think home blood glucose monitoring is of great value in improving diabetic control whether or not an insulin infusion pump is used. We showed that it is feasible without major technical problems to teach high-risk pregnant women to manage insulin therapy by CSII, based on frequent home monitoring of blood glucose concentrations with a portable reflectance meter. This could likely be done from the time pregnancy is determined until delivery. If this were accomplished, maternal and fetal morbidity might be substantially reduced. We suggest that larger trials of CSII and home glucose monitoring be carried out throughout high-risk diabetic pregnancies to determine their impact on the prevalence and severity of maternal and fetal complications.

Summary

Two high-risk diabetic women were treated with continuous subcutaneous insulin infusion and self-monitoring of blood glucose levels for glucose regulation during the final 15 weeks of pregnancy in one patient and the final 23 weeks in the other. In both patients, control of glucose levels was better than when CSII was not used. Because diabetes during pregnancy increases risks to the mother and the fetus, good glucose control is desirable. Continuous subcutaneous insulin infusion and home monitoring of blood glucose concentration are practicable and can be used to improve diabetes control during high-risk pregnancies.

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